APPENDIX A
FIELD CORING DATASHEETS

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-01	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample	200 cm	Diameter of Sample (inches)	3
Sampled Length (feet; from log	200 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	200 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections: Theoretical Depth (cm) Actual	Classification and Remarks
20cm			NO	gray	20cm	non-laminated silty mud
40cm					40cm	
60cm	0-60				60cm	
80cm				black	80cm	
1M					1M	
120cm	60-120				120cm	
140cm	120-140		Increasing Sulphur	dark gray	140cm	
						increasing fine sand & silt - "silty mud"
160cm					160cm	medium sand
180cm				gray	180cm	
2M	150-200				2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-02	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	72 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	72 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Theoretical Depth ( ) Actual Core Sections	Classification and Remarks
20cm					20cm	
	0-30					Fine Sand 24-30 ~85% 2-4 mm Fish Scales
40cm			Sulphur	dark gray	40cm	Silty Mud w/45-50% Fish Scales
	30-45					Silty Mud w/ ~30% Fish Scales and whole clam
60cm	45-59				60cm	
	No sample					
	65-72					
80cm					80cm	
1M					1M	* This core is in front of cannery scales probably associated with Cannery operations
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Privileged and Confidential - Prepared in Furtherance of Joint Defense

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-03	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	86 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	86 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections Depth ( ) Theoretical / Actual	Classification and Remarks
0–30 cm	0-30		Sulphur	dark gray	20cm	silty fine sand
30–38 cm	30-38			black	40cm	silty mud ~10 % organics some shells
38–68 cm	38-68			dark gray	60cm	silty/muddy fine sand
68–86 cm	68-86				80cm	fine sand well sorted

Depth scale: 20cm, 40cm, 60cm, 80cm, 1M, 120cm, 140cm, 160cm, 180cm, 2M

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-04	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	99 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	99 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Theoretical / Actual Core Sections	Classification and Remarks
20cm	0-25		Sulphur	dark gray	20cm	silty fine sand
40cm	0-50				40cm	silty fine sand w/30-40 mm clam shells and 10-20% fish scales
60cm					60cm	fine sand grading downward to medium sand
80cm				lighter dark gray	80cm	
1M	50-99				1M	
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-05	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	1.34 m	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	1.34 m	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Theoretical Depth ( ) Actual — Core Sections	Classification and Remarks
0–60cm	0-60		Sulphur	dark gray		silty fine sand
60–134cm	60-134					fine to medium sand well sorted

Depth scale: 20cm, 40cm, 60cm, 80cm, 1M, 120cm, 140cm, 160cm, 180cm, 2M

Privileged and Confidential - Prepared in Furtherance of Joint Defense

Visual Classification of Undisturbed Sample

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-06	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	2.0 m	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	2.0 m	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Core Sections (Theoretical / Actual)	Classification and Remarks
20cm					20cm	silty/fine-sand mud
40cm	0-40				40cm	
60cm					60cm	
80cm					80cm	fine sand well sorted
1M			Sulphur	dark gray	1M	
120cm	40-120				120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M	120-200				2M	

Visual Classification of Undisturbed Sample

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-07	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	170 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	170 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Theoretical / Actual — Core Sections	Classification and Remarks
20cm					20cm	
40cm					40cm	silty/fine sand mud
60cm	0-60				60cm	
80cm					80cm	
1M			Sulphur	dark gray	1M	fine sand well sorted with some shells
120cm					120cm	
140cm					140cm	
160cm					160cm	root zone in silty sand
	60-170					
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-08	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	90 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	90 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Theoretical Depth ( ) Actual Core Sections	Classification and Remarks
0–30cm	0-30		Sulphur	dark gray	0–30cm	silty muddy fine sand
30–90cm	30-90				30–90cm	fine to medium sand with shell fragments (< 5%)

Depth scale: 20cm, 40cm, 60cm, 80cm, 1M, 120cm, 140cm, 160cm, 180cm, 2M

Privileged and Confidential - Prepared in Furtherance of Joint Defense

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-09	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	110 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	110 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Theoretical / Actual — Core Sections	Classification and Remarks
0–35 cm	0-35		Sulphur	dark gray		non-laminated silty mud
35–110 cm	35-110		Sulphur	dark gray		medium to coarse sand with well rounded oblong pebbles (30-50 cm)

Depth scale: 20cm, 40cm, 60cm, 80cm, 1M, 120cm, 140cm, 160cm, 180cm, 2M

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-10	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample	83 cm	Diameter of Sample (inches)	3
Sampled Length (feet; from log	83 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)		Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections Depth ( ) Theoretical / Actual	Classification and Remarks
20cm–40cm	0-55		None	dark gray grading to olive green	20cm–40cm	fine to medium silty sand with 10-15% shell fragments and whole clam shells
60cm–80cm	55-83				60cm–80cm	fine to medium sand with some shell fragments (<5%)
1M					1M	
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Privileged and Confidential - Prepared in Furtherance of Joint Defense

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-11	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample	63 cm	Diameter of Sample (inches)	3
Sampled Length (feet; from log	63 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)		Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections: Theoretical Depth ( ) Actual	Classification and Remarks
20cm	0-43		None	dark gray	20cm	non-laminated silty mud
40cm					40cm	
60cm	43-63				60cm	fine to medium sand
80cm					80cm	
1M					1M	
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

Job	Orange County Coast Keeper - Rhine Channel	Date	
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-12	Type of Sample	☐ Shelby ☐ Vibrac [x] Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	99 cm	Sample Quality	Good [x] Fair ☐ Poor ☐
Sample Recovery (feet)	99 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections: Theoretical / Depth ( ) / Actual	Classification and Remarks
0–45 cm	0-45		None	dark gray		muddy silty fine sand
45–99 cm	45-99			olive green		medium to coarse sand with < 5% 10-30 mm polished pebbles

Depth scale: 20cm, 40cm, 60cm, 80cm, 1M, 120cm, 140cm, 160cm, 180cm, 2M

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/11/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-13	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	83 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	83 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Core Sections: Theoretical / Depth ( ) / Actual	Classification and Remarks
20cm					20cm	muddy silty fine sand
40cm	0-50		None	dark gray	40cm	
60cm					60cm	silty fine sand (5-10% mud)
80cm	50-83				80cm	
1M					1M	
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	11/11/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-14	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	
Sampled Length (feet; from log	59 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	59 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Theoretical Depth ( ) Actual Core Sections	Classification and Remarks
20cm			None	dark gray	20cm	muddy/fine sand
40cm	0-40				40cm	
60cm	40-59				60cm	fine sand
80cm					80cm	
1M					1M	
120cm					120cm	
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-15	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	153 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	153 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Theoretical / Actual Core Sections	Classification and Remarks
20cm			None	dark gray to olive green	20cm	
40cm	0-40				40cm	non-laminated silty/fine sand mud
60cm					60cm	
80cm	40-80				80cm	
1M					1M	medium sand with shell fragments (10-15%)
120cm					120cm	
140cm	80-153				140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

Job	Orange County Coast Keeper - Rhine Channel	Date	11/10/2004
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	D. Keith
Sample No.	RS04-16	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	3
Sampled Length (feet; from log	1.5 m	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	1.5 m	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Theoretical Depth ( ) Actual Core Sections	Classification and Remarks
20cm, 40cm	0-50				20cm, 40cm	non-laminated silty/fine sand mud
60cm, 80cm, 1M	50-100		light Sulphur	dark gray	60cm, 80cm, 1M	
120cm, 140cm	100-150				120cm, 140cm	fine to medium sand with < 5% shell fragments
160cm, 180cm, 2M					160cm, 180cm, 2M	

Visual Classification of Undisturbed Sample

ANCHOR ENVIRONMENTAL, L.L.C.

Job	Orange County Coast Keeper - Rhine Channel	Date	2/9/05
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	J. Edmunds
Sample No.	RS2-14	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	
Sampled Length (feet; from log)	120 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	120 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Theoretical / Actual Core Sections	Classification and Remarks
			None	dark gray		
20cm					20cm	fine silt
40cm					40cm	
	0-47					
	47-55					silty sand
60cm					60cm	
80cm					80cm	medium sand
	55-92					
1M					1M	(large red river rock at 1M)
						coarse gravel
120cm	92-120				120cm	
				gray		
140cm					140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

Visual Classification of Undisturbed Sample

Job	Orange County Coast Keeper - Rhine Channel	Date	2/9/05
Job No.		Sample Pushed By	S. Cappellino
Exploration No.		Sample Logged By	J. Edmunds
Sample No.	RS2-16	Type of Sample	☐ Shelby ☐ Vibrac ☒ Piston
Depth of Sample		Diameter of Sample (inches)	
Sampled Length (feet; from log)	140 cm	Sample Quality	Good ☒ Fair ☐ Poor ☐
Sample Recovery (feet)	140 cm	Average % Compaction =	

DEPTH ( )	Sample Interval	Sample Analytes	ODOR	COLOR	Depth ( ) Core Sections (Theoretical / Actual)	Classification and Remarks
			None	dark gray		
20cm					20cm	fine silty sand
40cm					40cm	
	0-53					
60cm	53-59				60cm	silty sand
						fine sand
80cm					80cm	
	59-92					
1M	92-99				1M	clay lense
120cm					120cm	fine to medium grain sand
140cm	99-140			gray	140cm	
160cm					160cm	
180cm					180cm	
2M					2M	

APPENDIX B
CHEMICAL ANALYSIS PROCEDURES

Determination of Mercury Speciation in Rhine Channel Sediments

Jennifer L. Parker, Research Scientist
Studio Geochimica
4744 University Way NE, Seattle WA 98105
February 22, 2005

I. Scope

A total of 6 samples were submitted for the determination of total and methyl Hg analysis.

II. Sample Receipt

Studio Geochimica received the sediment samples on February 10, 2005. Samples were frozen and were placed in a freezer upon receipt. Several of the sample containers were broken because the containers were filled too full upon collection. Cross contamination was not an issue because samples were individually bagged according to sampling location.

III. Sample Analysis

General. Samples were received and logged in according to Studio Geochimica protocols on the day of receipt. Samples were processed using ultra-clean sample handling techniques in a laboratory known to be low in atmospheric Hg. Reagents, gases, and DI water are all reagent or ultra-pure grade, and previously analyzed for Hg and trace metals to ensure very low blanks. Inorganic Hg (THg) standards are prepared by direct dilution of NIST certified NBS-3133 10.00 mg/mL Hg standard solution, and results are independently verified by the analysis of NIST-1641d (fresh water CRM, 200x dilution; 7,950 ng/L THg). Monomethyl mercury standards were made from the pure powder, diluted into a mixture of 5% acetic acid and 0.2% HCl, and then accurately calibrated for monomethyl mercury (equal to total Hg minus ionic Hg) against NBS-3133. Monomethyl mercury results were also cross-verified by daily analysis of NRCC DORM-2 (4,470 $\pm$ 370 ng/g MMHg).

All results have been corrected both for the mean reagent blank (a trivial fraction of most observed concentrations), and for instrumental drift throughout the day. This correction is made by taking the average recovery for adjacent continuing calibration verifications (CCVs), and using this value to correct all of the measured data points between those two CCVs. In general, this results in a correction in the range of 2-15% of the raw measured values, depending upon the room temperature range during the day (with CVAFS, instrumental sensitivity is somewhat influenced by the ambient temperature).

Percent Moisture (Dry Fraction). Approximately 5-10 grams of soil was weighed to the nearest 1 mg into pre-weighed disposable aluminum pans. The samples were then heated to 105 ^{o}C for 12-15 hours in a vented convection oven, and then taken out and allowed to cool for 10 minutes to room temperature. The samples were again weighed to the nearest 1 mg. From these data, the dry fractions (net dry mass (g)/net wet mass (g)) were calculated.

Monomethyl Mercury in Sediments. CH_3Hg was determined using extraction of an approximately 0.5 gram sample aliquot, weighed to the nearest milligram, with 5 mL of an $KBr/H_2SO_4/CuSO_4$ mixture. The CH_3Hg as the bromide is extracted into 10 mL of methylene chloride. Finally, 2.0 mL of the solvent is back-extracted by evaporation into 57.6 mL of deionized water for analysis by aqueous phase ethylation, isothermal GC at 100 ^{o}C, pyrolytic decomposition, and CVAFS detection. The solvent extraction procedure overcomes the positive artifact formation that had been observed previously when the more common distillation extraction is applied to sediments and soils (Bloom et al., 1997).

Total Mercury in Sediments. Approximately 0.5 grams was digested using aqua regia (8mL HCl + 2 mL HNO_3). Samples were allowed to sit overnight and were then diluted to 40 mL with reagent water. Mercury was then quantified using $SnCl_2$ reduction, purge and trap dual amalgamation CVAFS as described above and concentrations were reported in ng g^{-1}.

IV. Analytical Issues

No significant analytical problems were noted. All blanks and estimated detection limits were low and typical of the methods employed. All recoveries were good, with precision of results more than 10 times the detection limits typically about 5% relative percent difference (RPD).

V. References

Bloom, N.S., Coleman, J.A., and Barber, L. 1997. “Artifact Formation of Methyl Mercury During Extraction of Environmental Samples by Distillation.” *Fres. Anal. Chem.* 358: 371-377.

APPENDIX C
REVIEW OF CHANNEL AND STRUCTURAL CONDITIONS

Anchor Environmental, L.L.C.
1423 3rd Avenue, Suite 300
Seattle, Washington 98101
Phone 206.287.9130
Fax 206.287.9131

Draft Memorandum

To: Orange County Coastkeeper

From: Anchor Environmental, L.L.C.

Date: April 13, 2005

Re: Review of Structural Components and Existing Conditions

Rhine Channel, Newport Beach, California

This memorandum provides a brief description of existing structural components and conditions along the banks of the Rhine Channel in Newport Beach, California. The work was conducted in November 2004 by Anchor Environmental using aerial photographs, surveys, and site visits.

1 SITE BACKGROUND

The Rhine Channel is a body of water located at the west end of Newport Harbor in the old, industrial cannery and shipyard sector (photo 1). The channel tops Southern California's Environmental Protection Agency (EPA) 1998 list of impaired water-bodies as a "toxic sediment hot spot." Early studies suggest high amounts of mercury, copper, zinc, PCB and DDE toxins as well as a suspected debris field of industrial and marine waste dumped there over the decades. Historic records indicate that the sediments in the Rhine Channel have been contaminated since the 1930s when the channel was lined with shipyards, metal plating facilities, and a cannery. It appears that a significant amount of debris such as batteries, engines, and large pieces of metal and wood have been deposited in the Rhine Channel over time. In addition, runoff from the facilities on the channel and in the surrounding watershed has contributed to chemical contamination of the sediments.

Photo 1. The Rhine Channel is located at the west end of Newport Harbor in the industrial sector.

2 PURPOSE OF PROJECT

Orange County Coastkeeper is the lead agency overseeing this study, which began June 8, 2004. The Rhine Channel Project is a continuing effort to improve water quality and is funded by the state of California through Proposition 13. Orange County Coastkeeper is partnering with the city of Newport Beach to conduct this 10 month long study and propose a remediation plan that would comply with the toxics TMDL. The proposed grant-funded project will also include a survey of the debris field and chemical characterization of the sediment in an effort to determine the quality and volume of sediment that is contaminated. The project will also include developing and evaluating alternatives for remediating the contaminated sediments.

3 CHANNEL CHARACTERISTICS

The Rhine Channel is approximately 2,300 feet long and consists of two reaches (photo 2). The outside reach (R1) extends from the mouth of the channel to the bend, and is oriented to the northwest. The inside reach extends from the bend in the channel to the end and is oriented to the north. Figures 2A and 2B in the main text of the accompanying report show a two-part plan view of the channel and includes station designations that will be used throughout this document. Table 1 displays the basic channel characteristics of both reaches.

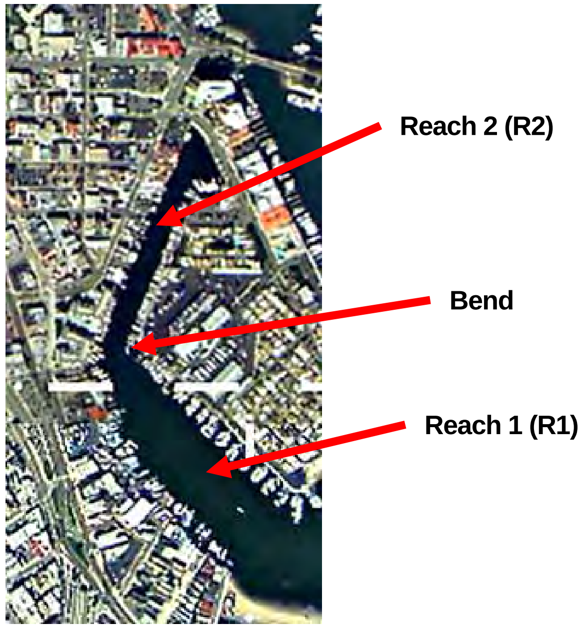


Photo 2. Two reaches of the Rhine Channel

Table 1
Channel Characteristics

Reach	Reach 1 (R1)	Reach 2 (R2)
Relative location	Outside	Inside
Length	1300 ft	1000 ft
Width, sea wall to sea wall	450 ft	200 ft
Working width	300 ft	100 ft
Depth of the middle	11.5 ft	11ft
Depth of the bend	11.5 ft	11.5 ft

4 DESCRIPTION OF CHANNEL BANK

4.1 Bulkheads

The entire bank of the Rhine Channel has been developed into housing, restaurants, small businesses, and marine support services. The channel's perimeter is approximately 5,000 feet long and mainly comprises a concrete slab bulkhead. Occasionally the bulkhead is supported by steel tiebacks as depicted in photo 3. Some of the tiebacks appear to have been installed post construction. The top of the bulkhead is at approximately 10 to 12 feet MLLW in elevation. A concrete cap rests on top of the bulkhead.

Photo 3. Steel tieback supporting concrete bulkhead

4.2 Rip Rap

One section of the bank is armored by rip rap instead of the concrete slab. The rip rap bank is about 60 feet long and appears to be in stable condition.

Photo 4. Rip rap at station 5+75

4.3 Natural Slope

On the east side of R2 from station 4 +50 to 6+00, an area of natural slope extends into the channel (photo 5). The bank contains some concrete debris and a timber bulkhead. The timber bulkhead is supported by soldier piles on 5 foot centers with wood laggings. The slope rises above the high water mark to the underside of a wood deck in front of private residences.

Photo 5. Natural slope at station 4 + 50 of Reach 2

4.4 Floating docks

Most docks along the channel are floating systems tied to concrete guide piles (photo 6). The docks are free to move with the water height on a series of rollers. The docks are oriented in various alignments; they are parallel, perpendicular, or diagonal to the bank. Along the west side of R1, the docks surrounding the channel typically extend 60 feet out into the waterway and are 15 feet apart. On the east side of R1, the docks can be up to 35 feet apart and house up to eight boats in a herringbone pattern. In R2, the west side docks are typically 35 feet long and 15 feet apart.

Photo 6. Typical floating dock with concrete piles

4.5 Ramps and Sinker Lifts

Two boat ramps are located near station 13+00 along R1. One is on the east side and one is on the west side of the channel. At station 16+00 in R1 on the west side there is a boat lift operated by a boatyard. And as depicted in photo 7, a sinker lift is located on the west side of the channel near station 18+00. The sinker lift has approximately 5 feet of clearance at mid-tide and has very little access underneath. Sonar images depict what appears to be a large debris field in the waterway near the sinker lift. Old boat parts, container doors, and perhaps a car are speculated to be in this debris field.

Photo 7. Sinker lift near station 18+00

5 INDICATIONS OF STRUCTURAL WEAR AND DAMAGE

The bulkhead appears to be structurally sound along most of its length with some cracking and deterioration of the outer surface material evident in many areas. There are three main locations where the integrity of the bulkhead appears to be in poor condition. Of the approximately 5,000 feet of concrete bulkhead, about 390 feet appear to be failing. This represents approximately 8 percent of the total length of bulkhead along the channel. However, if material is to be dredged near the bulkhead, measures may be needed to either shore up the failing portions or reconstruct the sections entirely.

5.1 Bulkhead Failure

Specifically on the west side R2 near station 7+00, disintegrating concrete in the cap has exposed rebar supports (photo 8). Spalling of the concrete is also prominent.

Photo 8. Bulkhead failure at station 7+00

On the east side of R2 near station 3 + 20, the bulkhead also appears to be failing. It is currently being supported by post-construction tiebacks.

Finally, on the west side of R1 near station 11+50, the bulkhead is cracking and the cap appears to be deteriorating (photo 9).

Photo 9. Bulkhead failure at station 11+50

5.2 Cracking Piles

Some of the floating piling appear to be in poor shape. Any disturbance of these piling during construction will likely require full replacement of the piles. Photo 10 shows excessive cracking of the concrete on the west side of R2 from station 7+50 to 11+00.

Photo 10. Cracks in concrete piling

5.3 Outfall pipes and storm drains

Storm drains release into the channel in various locations along the bulkhead. The stormwater is discharged directly into the channel. Photo 11 shows an exposed outfall pipe on the west side of the channel, off of 26th Street, near station 12+00.

Photo 11. Exposed storm drain

5.4 General Cracks and Deterioration

Some locations around the perimeter of the channel have superficial cracks in the apron or sidewalk above the bulkhead (Photo 12). There is also evidence of deterioration of the concrete that appears not to affect structural integrity of the bulkhead. If dredging operations and heavy machinery are working in the vicinity of these areas, attention will need to be paid to prevent worsening of the condition. In some areas, repairs or reconstruction will need to take place if significant damage is done.

Photo 12. Cracks in sidewalk

Photo 13. Cracks in apron

6 CONCLUSION

The entire shoreline of the Rhine Channel is developed either by residential housing or commercial businesses. The channel's perimeter is approximately 5,000 feet long and mainly comprises a concrete slab bulkhead. The perimeter also consists of one 60-foot section of rip rap and one 150-foot section of natural slope.

For the most part, the bulkhead is in stable condition and should withstand the effects of activity in the channel related to sediment remediation. About 390 feet (8 percent) of the bulkhead is in poor condition or completely failing, and would requiring shoring or complete replacement if work is to be conducted that would jeopardize the bulkhead integrity.

The other significant obstacles to sediment remediation are the floating piers and guide piles that line the banks of the channel. These structures will likely require demolition/disassembly and reassembly after the remediation work is completed.

APPENDIX D
TROPHIC TRACE RISK ASSESSMENT

FOCUSED ECOLOGICAL RISK ASSESSMENT – BIOACCUMULATION MODELING

RHINE CHANNEL SEDIMENT REMEDIATION NEWPORT BAY, CALIFORNIA

Prepared for

Orange County Coastkeeper

Prepared by

Anchor Environmental, L.L.C.

1423 Third Avenue, Suite 300

Seattle, Washington 98101

April 2005

Table of Contents

List of Tables

List of Figures

List of Attachments

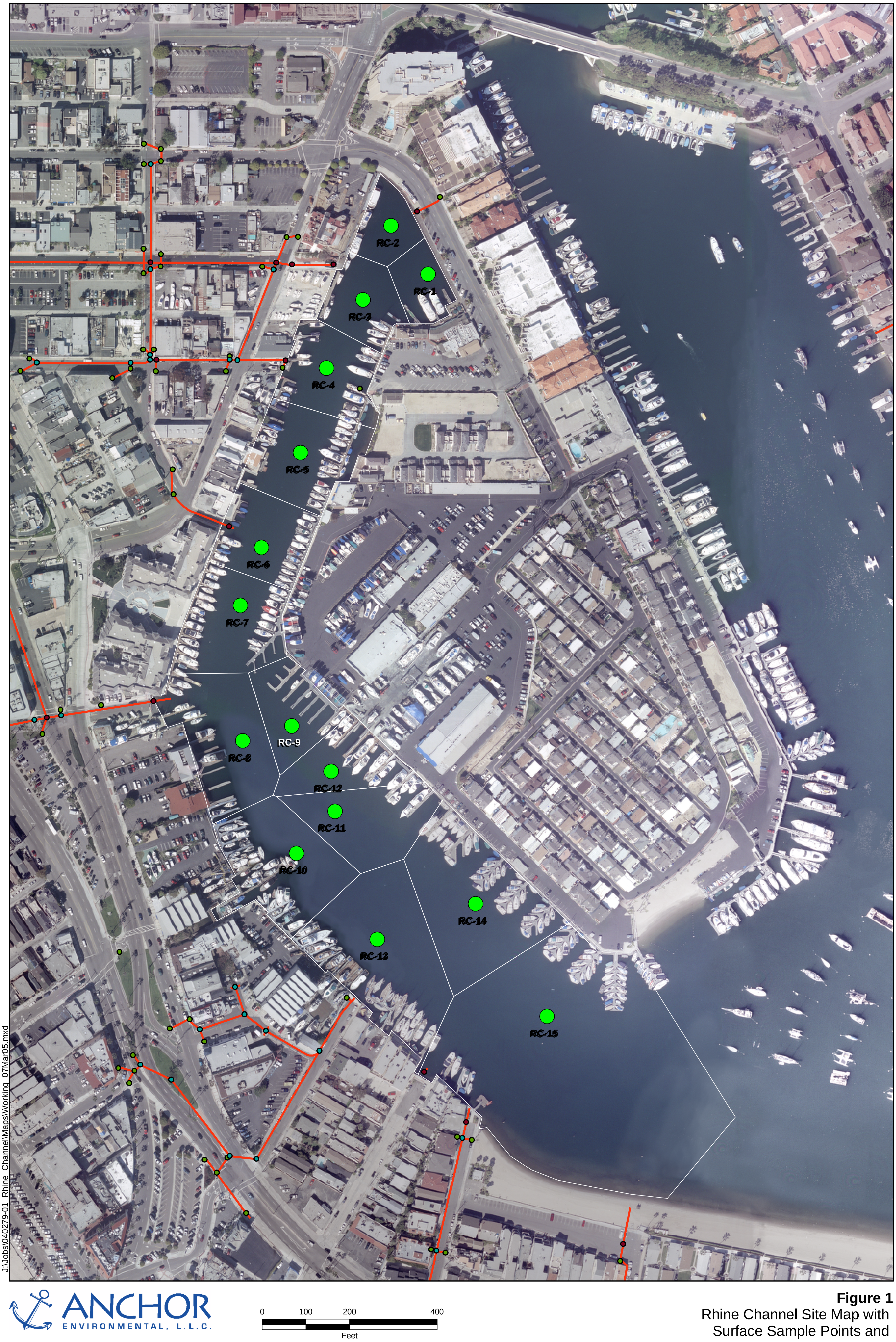
1 INTRODUCTION

The Rhine Channel is a body of water located at the west end of Newport Bay in the old, industrial cannery and shipyard sector (Figure 1). The channel tops Southern California's Environmental Protection Agency (CalEPA) 1998 list of impaired water-bodies as a "toxic sediment hot spot." Early studies suggest high amounts of mercury, copper, zinc, polychlorinated biphenyls (PCB) and dichlorodiphenyldichloroethylene (DDE, a breakdown product of DDT) toxins, as well as a suspected debris field of industrial and marine waste dumped in the channel over time. Historic records indicate that the sediments in the Rhine Channel have been contaminated since the 1930s when the channel was lined with shipyards, metal plating facilities, and a cannery. It appears that a significant amount of debris (such as batteries, engines, and large pieces of metal and wood) has been deposited in the Rhine Channel over time. In addition, runoff from the facilities on the channel and in the surrounding watershed has contributed to chemical contamination of the sediments. Recent sediment data show that in areas of the channel where the highest concentrations of some contaminants were recorded, pollutants exceed levels above which adverse effects to marine benthos is expected. In addition, sediment toxicity has been observed in amphipod and sea urchin toxicity tests. (Anchor 2005; Coastkeeper 2005).

This focused ecological risk assessment (EcoRA) is part of an ongoing study evaluating the cleanup of contaminated sediment in the Rhine Channel. The Rhine Channel project is a continuing effort to improve water quality and is funded by the state of California through Proposition 13. Orange County Coastkeeper is partnering with the city of Newport Beach to conduct this 10-month-long study and propose a remediation plan that would comply with the Toxics Total Maximum Daily Load (TMDL). The proposed grant-funded project will also include a survey of the debris field and chemical characterization of the sediment in an effort to determine the quality and volume of sediment that is contaminated. The project will also include developing and evaluating alternatives for remediation of the contaminated sediments. (Coastkeeper 2005). The goal of this EcoRA is to provide an estimate of baseline risk from bioaccumulation of contaminants to higher trophic levels of fish, birds, and marine mammals for use in informing cleanup decisions.

Specifically, this EcoRA addresses the potential for food chain transfer of sediment-associated contaminants, including selected metals, PCBs, and DDE, to higher trophic levels of fish, birds, and marine mammals. The Gobas steady-state uptake model was used to evaluate non-polar organic compounds (PCBs and DDE), and a bioconcentration factor (BCF) approach was applied for the inorganic metals, copper, mercury, and selenium. Both the Gobas model and BCF model are included as parts of the U.S. Army Corps of Engineer (Corps) Trophic Trace (Version 3.04; November 2003a) software developed by the Waterways Experiment Station (WES) for use in evaluating dredged material (www.wes.army.mil/el/trophictrace).

This report documents the focused screening-level EcoRA that was performed specifically to evaluate bioaccumulation risk using the Trophic Trace model. The following sections generally follow the U.S. Environmental Protection Agency (USEPA 1998a) guidelines for ecological risk assessment and include a problem formulation, exposure characterization, effects characterization, and risk analysis and uncertainty evaluation. In addition, the following sections also reference the data entry screens in Trophic Trace to allow the reader to recreate the modeling effort. The Trophic Trace output file is presented in Attachment 1 of this report. The Trophic Trace Microsoft Excel input file is available upon request from Dan Hennessy of Anchor Environmental, L.L.C. (dhennessy@anchorenv.com).



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Rhine Channel Site Map with Surface Sample Points and Thiessen Polygon Boundaries

2 PROBLEM FORMULATION

Exposure to sediment-associated contaminants of potential concern (COPCs) depends on the physical fate and transport of the COPCs as well as the ecological characteristics of the receptors of concern (ROCs). The potential longer-term exposure of the ROCs to sediment COPCs may occur by direct contact or ingestion of sediments and surface water, as well as food chain transfer of contaminants by sediment or water dietary pathways.

2.1 Environmental Setting

The Rhine Channel is approximately 2,300 feet long and consists of two reaches, separated by a slight bend in the channel alignment. The outer reach (Reach 1) extends from the mouth of the channel to the bend, and is oriented to the northwest. The inner reach (Reach 2) extends from the bend in the channel to the head of the channel and is oriented to the north. Reach 1 is approximately 1,300 feet long and 450 feet wide. Reach 2 is approximately 1,000 feet long and 125 feet wide. The approximate area of the Rhine Channel is approximately 7 hectares. The depth of the Rhine Channel averages approximately -11 feet mean lower low water (MLLW).

The entire bank of the Rhine Channel has been developed into housing, restaurants, small businesses, and marine support services. The channel's perimeter is approximately 5,000 feet long and is mainly comprised of a concrete slab bulkhead. The top of the bulkhead is approximately 10 to 12 feet MLLW in elevation. A concrete cap rests on top of the bulkhead. Smaller sections of rip rap (60 feet long) and natural slope (150 feet long) are also present. Most docks along the channel are floating systems tied to concrete guide piles. The docks are free to move with the water height on a series of rollers. The docks are oriented in various alignments; they are parallel, perpendicular, or diagonal to the bank. Two boat ramps and a sinker lift are also present. Storm drains release into the channel in various locations along the bulkhead. The stormwater is discharged directly into the channel.

2.2 Resources Potentially at Risk and Receptor Selection

A number of ecological resources may utilize the Rhine Channel and surrounding areas including potential use by threatened, endangered, and sensitive species. For the purpose of this evaluation, three groups of species were evaluated as ROCs: fish, birds, and aquatic mammals. In previous studies, benthic infaunal species were directly evaluated as ROCs based on comparison to sediment quality guidelines and toxicity tests (SCCWRP 2003); these studies found risk to benthos from sediment-associated contaminants is likely.

The selection of species as ROCs was made under consideration of the ecology of a typical southern California delta embayment environment. Information on the fish was obtained from the California Department of Fish and Game (CDFG) marine sport fish identification webpage (CDFG 2003a), CDFG fish bulletins (CDFG 2002; Lane and Hill 1975), U.S. Fish and Wildlife Service species profiles (www.nwrc.gov/publications/specintro.htm), and relevant texts on seashore biology (Ricketts et al. 1985; Kozloff 1993; Smith and Carlton 1975). Information on birds and mammals was obtained from the California Wildlife Habitat Relationships System (CDFG 2003b) and local sources (Audubon 2004; Coastkeeper 2005; Orange County 2005). The ROCs evaluated in this EcoRA are summarized in Table 1.

Table 1
Summary of Species Evaluated for Bioaccumulation Risk Assessment

Trophic Guild	Species	Environment	Reason for Selection
Fish			
Planktivorous fish	California killifish (*Fundulus parvipinnis*)	Shallow, sheltered waters. High site fidelity	Prey item for piscivorous fish and birds. Feeds throughout the water column
Benthivorous fish	Arrow goby (*Clevelandia ios*)	Shallow water, soft bottom substrate	Prey item for fish and birds. Consumes benthos. Burrows in sediments.
	Diamond turbot *(Hypsopsetta guttulata)*	Shallow water, soft bottom substrate	Prey item for harbor seal. Consumes benthos
Piscivorous fish	California halibut (*Paralichthys californicus*)	Shallow and deep waters, soft bottom substrate	Prey item for harbor seal. Consumes fish
Birds			
Piscivorous birds	Brown pelican (*Pelecanus occidentalis*)	Open water/channel island rookeries	State and federally endangered species
	Double crested Cormorant *(Phalacrocorax auritus)*	Open water/rocky headlands and islands.	Common around wharfs and areas with little vegetation. Can have high site fidelity. Commonly used as environmental indicator species.
Mammals			
Piscivorous mammal	Harbor seal (*Phoca vitulina*)	Nearshore habitats.	Common pinniped. Consumes fish.

2.3 Chemicals of Potential Concern

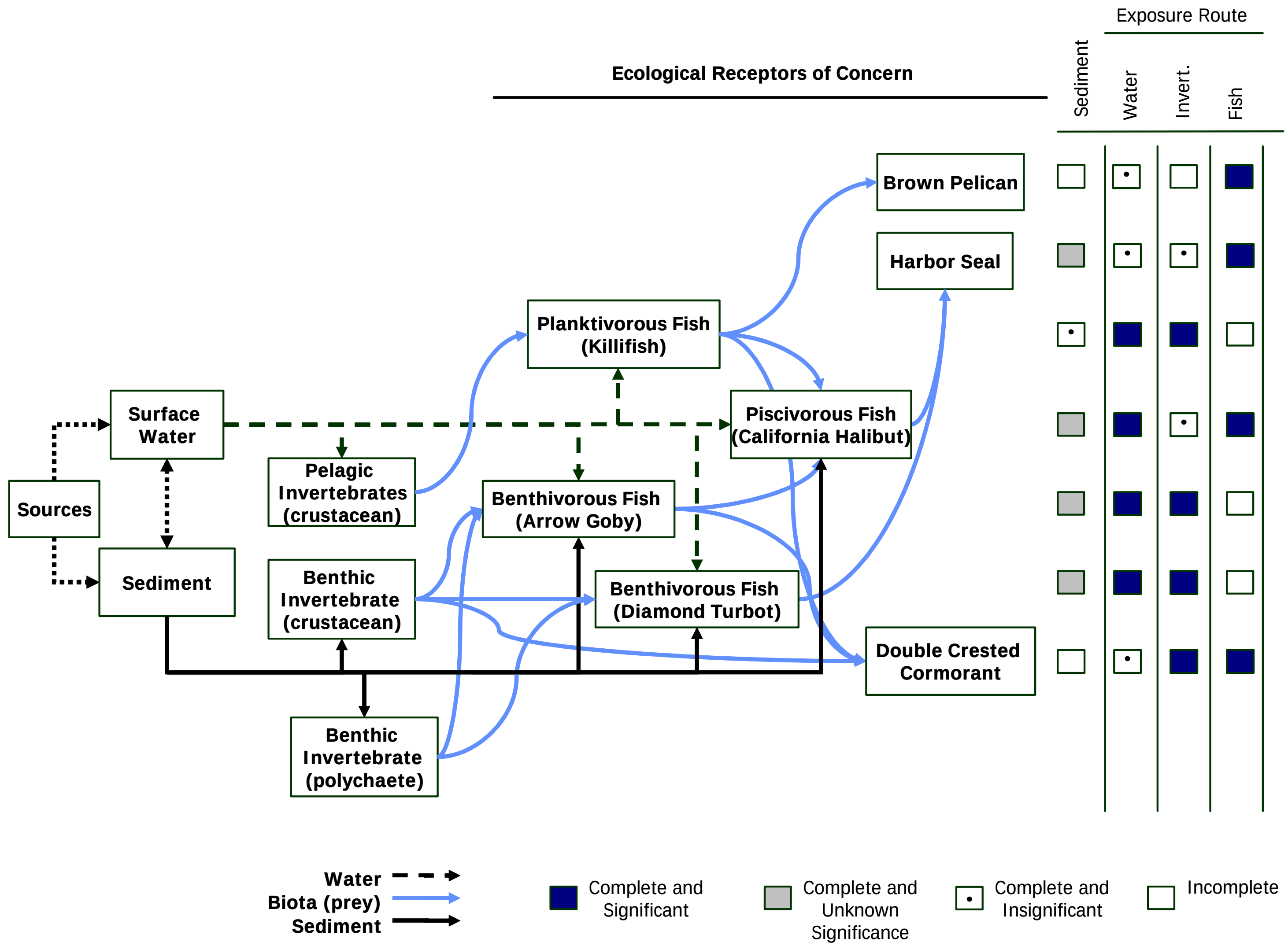
The selection of CPOCs was based on the screening of sediment surface data (top 10 cm) chemistry against established sediment quality guidelines (SQGs). Use of this sediment data set represents existing conditions and assumes that the system is at a steady state and that the only route of exposure is direct contact with the surface sediments, porewater, or surface water (i.e., the modeled exposure does not address resuspension or disturbance of sediment). While a number of chemicals in the Rhine Channel surface sediments exceeded the SQGs established for the protection of benthos (SCCWRP 2004a), a more stringent screen was applied to determine the primary bioaccumulative CPOCs. Specifically, the sediment data were compared to the bioaccumulation trigger values established by the Puget Sound Dredged Material Management Office (Corps 2003b). Chemicals with a maximum concentration more than one-half the bioaccumulation trigger value (copper, mercury, selenium, DDE[1], and total PCBs) were retained for further assessment in this focused EcoRA.

2.4 Conceptual Site Model

The conceptual site model was primarily based on trophic transfer of the COPCs through the food chain from sediment and/or water → invertebrates → forage species → piscivorous species as generally framed by the Trophic Trace model. In addition to the dietary exposure, water exposure to the ROCs was also implicitly evaluated by the model for the fish via the Gobas and BCF models. Water exposure to the bird and mammal receptors and direct sediment exposure to all ROCs was evaluated qualitatively and is discussed below in more detail.

The conceptual model defining the pathways to the seven ROCs that were modeled using Trophic Trace are depicted in Figure 2. The invertebrate, fish, and wildlife in this model were selected to represent a generic southern California bay food chain and address specific concerns about bioaccumulation of COPCs in sensitive or important species. These species are presented in Table 1. Additional discussion of the ecology of these species as it relates to the parameterization of the model is provided below in Section 3.

[1] Only DDE was detected in the Rhine Channel surface sediment. DDT and DDD were not detected.



ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2
Conceptual Site Model – Wildlife
Rhine Channel Sediment Remediation

2.4.1 Dietary Exposure Pathway

Two dietary pathways were evaluated, a sediment-based pathway and a water-based pathway. In this model, invertebrates determine whether the food chain was based on sediment or water diet pathways. At the beginning of this food chain were the following invertebrates:

- A benthic crustacean and a benthic polychaete to represent the sediment diet pathway
- A pelagic crustacean to represent the water diet pathway

At the second level of the food chain are organisms that prey on the invertebrates described above. In this model, two fish and one bird preyed on the invertebrates:

- Planktivorous fish (California killifish) feeding throughout the water column, primarily on pelagic invertebrates
- Benthivorous fish (diamond turbot and arrow goby) feeding on benthic polychaetes and crustaceans

At the third level of the food chain described in this model are organisms that prey on the planktivorous and benthivorous fish. This included two piscivorous bird species feeding exclusively on pelagic fish (brown pelican and cormorant) and one piscivorous fish species (California halibut). In addition, the model included a marine mammal (harbor seal) feeding on the two larger flatfish species (turbot and halibut).

2.4.2 Water Exposure Pathway

For the fish ROCs, the Trophic Trace model evaluates water exposure to organic compounds through the Gobas model which incorporates gill uptake and elimination into the tissue-burden estimates. For the metals, a BCF approach is used to estimate tissue burdens. For the wildlife ROCs, the water exposure pathway was not quantitatively evaluated. Seabirds drink seawater to maintain homeostasis; however, the dose was assumed to be insignificant compared to dietary pathways. Marine mammals derive freshwater from prey and metabolic processes. Although the water pathway is complete for wildlife, it was assumed to be insignificant.

2.4.3 Sediment Exposure Pathway

The direct sediment pathway was not complete for killifish or piscivorous birds (brown pelican and double-crested cormorant) ROCs. The sediment pathway was complete for three fish (arrow goby, California halibut, and diamond turbot) ROCs because these species are in direct contact with sediment and feed on sediment-associated prey. Sediment ingestion rates or absorption data were not available for fish; therefore, the significance of this pathway is unknown. For this assessment it was assumed that the dietary pathway was the primary driver of fish tissue burdens.

The sediment exposure pathway was complete for harbor seal because they feed on demersal fish such as halibut and diamond turbot. Sediment ingestion rates were not available for harbor seal and, therefore, the significance of this pathway is unknown. For this assessment it was assumed that the dietary pathway was the primary driver of risks to harbor seal.

2.5 Assessment Endpoints and Measures of Exposure and Effects

For all ROCs, the assessment endpoints were survival, growth, and reproduction. Three approaches to evaluating risk were evaluated for the ROCs: media-based exposure comparisons, dietary exposure comparisons, and tissue-residue comparisons. Toxicity reference values (TRVs) were selected based on the evaluation approach identified below in Section 4. Table 2 summarizes the ROCs, assessment endpoints, and measures of exposure and effects used to estimate risk.

Table 2
Summary of Receptors of Concern, Assessment Endpoints, and Measures of Exposure and Effects

Trophic Guild	Species	Assessment Endpoint	Measure of Exposure and Effect
Fish			
Planktivorous fish	California killifish	Survival, growth, and reproduction	Comparison of modeled tissue data to residue-effects data[1]
Benthivorous fish	Arrow goby	Survival, growth, and reproduction	Comparison of modeled tissue data to residue-effects data[1]
	Diamond turbot	Survival, growth, and reproduction	Comparison of modeled tissue data to residue-effects data[1]
Piscivorous fish	California halibut	Survival, growth, and reproduction	Comparison of modeled tissue data to residue-effects data[1]
Birds			
Piscivorous birds	Brown pelican	Survival, growth, and reproduction	Comparison of modeled site-specific exposure to TRVs
	Double crested cormorant	Survival, growth, and reproduction	Comparison of modeled site-specific exposure to TRVs
Mammals			
	Harbor seal	Survival, growth, and reproduction	Comparison of modeled site-specific exposure to TRVs

1: Copper was evaluated on a dietary basis.

3 EXPOSURE ASSESSMENT

This section describes the data that were used to parameterize the Trophic Trace model. The food chain analysis for the COPCs was conducted using the Gobas model feature provided in Trophic Trace. The following sections correspond to the data entry screens of Trophic Trace.

3.1 Chemicals

The factors describing chemical behavior in the food chain were a water-to-tissue parameter, a sediment-to-water parameter, and a sediment-to-biota parameter. The parameters describing organic chemical behavior in the food chain used in this evaluation were Kow, Koc, and a biota-sediment accumulation factor (BSAF) The parameters describing metals behavior in the food chain were used in this evaluation were a BCF, Kd, and trophic transfer factor (TTF) (Table 3).

The Kow values for PCBs and DDE were obtained from the toxicological profiles on the Agency for Toxic Substances and Disease Registry (ATSDR) web site (http://www.atsdr.cdc.gov/toxpro2.html). Koc was calculated from Kow using the Connell and Hawker equation as cited in the Trophic Trace users manual (VonStakelberg and Burmistrova 2003). The BSAF values were obtained from the WES BSAF database (http://www.wes.army.mil/el/bsaf/bsaf.html). The PCB BSAF is the mean of all PCB benthic field values. The BSAF used for DDE is the value for all pesticide benthic field studies. In the Trophic Trace (Version 3.04) examples for total PCBs and DDE, a BSAF of 1.7 was used, the default value used by the Corps (USEPA 1998b) for evaluating the theoretical lipid bioaccumulation potential of nonpolar organic compounds. Therefore, relative to this value, using the WES benthic average BSAF values for total PCBs and DDE is likely to result in a conservative estimate of food chain bioaccumulation.

BCF values for were obtained from several sources. It is important to note that predicting metals bioconcentration is more uncertain than similar predictions for nonpolar organics. As noted by McGeer et al. (2003), "bioconcentration and bioaccumulation factors do not distinguish between essential mineral nutrient, normal background metal bioaccumulation, the adaptive capabilities of animals to vary uptake and elimination within the spectrum of exposure regimes, nor the specific ability to sequester, detoxify, and store internalized metal from metal uptake that results in adverse effect." The BCF values applied herein were selected based on their use as recommended conservative screening guidelines.

For copper, the BCF of 1,000 was based on a compilation of bioconcentration relationships provided by McGeer et al. (2003) and was selected from the regression relationship for non-salmonid fish. As noted above, substantial uncertainty exists around the use of BCFs; the value selected was conservative based on measured copper concentrations in the Rhine Channel surface water which would have justified a lower BCF.

For mercury, the BCF of 30,000 was selected from USEPA (2004) concentration factors of metals in the marine environment. Although higher BCFs were reported (USEPA 1999b), these values were for divalent mercury (120,000) or methyl mercury (1,600,000), and the elemental mercury BCF value reported in this report is 1. Since neither total nor dissolved mercury were detected in the Rhine Channel by SCCRWP (2004a) and methylation has been demonstrated to be low, the use of the divalent or methyl mercury BCFs is not warranted. Based on site-specific data using the detection limit of the Rhine Channel surface water mercury analyses (0.005 μg/L) and the maximum fish tissue mercury value for whole body samples collected in the inner lower portion of Newport Bay (0.02 mg/kg), the estimated BCF is approximately 4,000. Therefore, the use of 30,000 as the mercury BCF for the modeling exercise is likely to be conservative.

For selenium, the BCF of 10,000 was selected from USEPA (2004) concentration factors of metals in the marine environment. Lower selenium BCFs were reported in another USEPA (1999b) data compilation. Neither total nor dissolved selenium were detected in the Rhine Channel by the Southern California Coastal Water Research Project Authority (SCCWRP 2004a). Therefore, the use of the literature selenium BCF of 10,000 for the modeling exercise was considered appropriate.

The Kd values for copper, mercury, and selenium were obtained from USEPA (1999a) compilation of partition coefficients for metals. The TTF values for copper, mercury, and selenium were obtained from USEPA (2000) compilation trophic transfer of metals in benthic invertebrate prey to finfish values.

Table 3
Summary of Chemical Parameters

Organic COPC	Kow	Koc	BSAF
PCBs (Total)	6.301	6.197	2.203
DDE	6.51	6.400	5.025
Metal COPC	**BCF**	**Log Kd**	**TTF**
Copper	1,000 [1]	3.5	0.21
Mercury	30,000 [2,3]	4.9	1
Selenium	10,000[3]	3.6	1

Notes:
1: Based on McGeer et al. (2003), Figure 4H, assumed copper water concentration 1 ppb.
2: USEPA 1999b
3: USEPA 2004 – fish filet BCF of 30,000. USEPA 1999b BCF value was not used (see Section 3.1 for discussion)
Kd – Metal Partition Coefficient for sediment/porewater. (Mean value from USEPA 1999b Table 5;)
TTF – Trophic Transfer Factor (USEPA 2000). These values are noted to be highly uncertain, although conservative
BCF – Bioconcentration Factor (L/kg).

3.2 Environment

The parameters used in the Trophic Trace model to define the environment at Rhine Channel were surface water temperature, total organic carbon (TOC) in sediment, and the concentrations of COPCs in sediment and surface water. The freely dissolved surface water concentrations of organic COPCs were calculated by the model from the sediment and TOC data using equilibrium partitioning. For the metals, the measured dissolved concentrations (SCCWRP 2004a) were applied[2]. Therefore, particulate organic carbon and dissolved organic carbon in surface water were not needed as input parameters.

Table 4 summarizes the water temperature and TOC values used in the model. The water temperatures used in the model were the averages reported by National Oceanic and Atmospheric Administration (NOAA) at Balboa, California, and Newport Beach, California, respectively (http://www.nodc.noaa.gov/dsdt/cwtg/spac.html). The TOC values used in the model were the minimum, mean, and 95 percent upper confidence level (95% UCL)of the

[2] Dissolved and total metals were measured in water column and sediment-water interface (SWI) samples taken midpoint in Rhine Channel at Station NB3 by SCWRRP (2004a). These values were used as the basis dissolved metals inputs to the model. Organic water samples were taken in the Newport Bay Turning Basin, not Rhine Channel. For this reason, the model calculation of organic water concentrations using equilibrium partitioning (EqP) were applied. The PCB and DDE water concentrations are included in Table 5 for comparison purposes.

mean concentrations measured in 2002 in the surface sediments in the Rhine Channel (SCCWRP 2003).

Table 4
Summary of Environmental Parameters

Parameter	Value
Water Temperature (°C)	16.8, 18.2
TOC in Sediment (%:)	1.0, 1.6, 1.95

Table 5 summarizes the sediment and dissolved water concentrations used in the model. The sediment concentrations used in the model were the minimum, mean, the 95% UCL of the mean, and the maximum values measured in 2002 in the Rhine Channel surface sediments (SCCWRP 2003). The Rhine Channel water column data were available for metals. The measured concentrations for metals were based on the water column and the SWI concentration that were measured at the bend of the Rhine Channel at Station NB3 (SCCWRP 2004a). For the modeled metal water concentrations, the SWI value was multiplied by 2, 4, and 6 respectively to provide a conservative safety factor. These multiples were input to the Trophic Trace model to apply the fuzzy math feature and were paired with the increasing sediment values (i.e., the minimum, mean, the 95% UCL of the mean, and the maximum values). PCB and DDE water column measures were made in Newport Bay at the Turning Basin. Because of uncertainty associated with the sampling technique and location outside of the Rhine Channel, the PCB and DDE concentrations applied in the model were those calculated by the model using equilibrium partitioning (EqP). The values measured in Turning Basin water samples (SCCWRP 2004a) are included herein for reference.

Table 5
Summary of Measured and Modeled Chemical Concentrations in Sediment, Porewater, and Surface Water

Chemical	Statistical Value	Sediment (ng/g dw)	Calculated (EqP) Porewater (ng/L)	Measured Water Concentrations (ng/L)
Copper	Min.	225,000	71,151	5,780
	Mean	654,000	206,813	11,560
	95% UCL	768,000	242,863	23,120
	Max.	957,000	302,630	34,680
Mercury	Min.	2,400	30	5
	Mean	9,000	113	10
	95% UCL	10,600	133	20
	Max.	14,300	180	30
Selenium	Min.	1,270	319	10
	Mean	2,360	593	20
	95% UCL	2,630	661	40
	Max.	3,120	784	60
DDE	Min.	30	0.612	0.336
	Mean	54.9	1.37	0.672
	95% UCL	63.7	1.58	1.34
	Max.	97.9	3.90	2.02
PCBs (Total)	Min.	51	1.66	0.146
	Mean	225.9	8.98	0.292
	95% UCL	279.1	11.1	0.584
	Max.	401	25.5	0.876

Notes:
The EqP concentration is equivalent to a porewater measurement.
The measured concentrations for metals were based on the water column and the sediment-water interface concentration that were measured at the bend of the Rhine Channel at Station NB3 (SCCWRP 2004a). The PCB and DDE concentrations applied in the model were those calculated by EqP; the values measured in Turning Basin water samples (SCCWRP 2004a) are included herein for reference. For the measured water concentrations, the base SWI value was multiplied by 2, 4, and 6, respectively, to provide a conservative safety factor.
Highlighted values are those water concentrations used in the model.

3.3 Organisms

This section describes the model parameters for the invertebrate, fish, and wildlife ROCs. This section follows the data input screens of Trophic Trace.

3.3.1 Invertebrates

Invertebrate lipid data were selected from the literature to most closely approximate the lipid content in the invertebrate prey likely to be found at the site (Table 6). Benthic infaunal assemblage data for shallow embayment areas of southern California were obtained from the SCCWRP Web Site (SCCWRP 1997), CDFG (Lane and Hill 1975), and relevant marine biology references (Kozloff 1993; Ricketts et al. 1985). Amphipods and polychaetes were the two most abundant infaunal groups in the shallow assemblage (SCCWRP 1997). Therefore, the two invertebrates modeled for the sediment diet pathway were a generic benthic polychaete and a generic crustacean. These two species were selected to represent the prey items of arrow goby and diamond turbot. The benthic polychaete lipid value used was the grand mean of the category "Polychaete misc." as reported in the WES BSAF database. The selected benthic crustacean lipid value was for the category marine crustacean as reported in the WES database.

For the water diet pathway, a generic pelagic crustacean modeled on copepods was used to represent the prey items of the pelagic fish (anchovy/grunion). The copepod lipid data were obtained from the WES database and the value used was the mean of copepod wet weight whole body lipid values.

Table 6
Summary of Invertebrate Model Parameters

Trophic Guild	Lipid % (ww)	Lipid Basis	Diet Pathway
Benthic Polychaete	1.461	WES Polychaete	Sediment
Benthic Crustacean	2.759	WES Marine Crustacean	Sediment
Pelagic Crustacean	5.14	WES Copepod	Water

Note
ww wet weight

3.3.2 Fish

Fish species were selected based on CDFG habitat assignments and CDFG and U.S. Fish and Wildlife Service (USFWS) species profiles. Fish lipid data, weights, and site use factors (SUFs) were selected to approximate the biological and ecological features of the fish likely to be found at the site. Table 7 summarizes the lipid, weight and SUF. Table 8 summarizes the dietary components of the modeled fish.

3.3.2.1 Planktivorous Fish – California Killifish

California killifish are a common omnivorous fish in shallow soft bottom environments of the Pacific coast and are a prey item of piscivorous fish and wildlife. Killifish feed throughout the water column and a large portion of their diet consists of planktonic species (Lane and Hill 1975). For this reason, killifish was used to model the water dietary pathway. For the model it was assumed that the generic planktonic crustacean comprised 100 percent of the diet. The lipid value and weight used in the model, 1.5 percent and 5 grams, respectively, were based on California killifish collected from Newport Bay (SCCWRP 2004b). A SUF of 1 was used for the killifish because these fish exhibit site fidelity (Lane and Hill 1975).

3.3.2.2 Benthivorous Fish – Arrow Goby

Arrow gobies are a common benthivorous fish in shallow soft bottom environments of the Pacific coast and are a prey item of piscivorous fish and wildlife. For the model it was assumed that the generic benthic polychaete and benthic crustaceans comprised equal portions of the diet. The lipid value and weight used in the model, 1.5 percent and 2 grams, respectively, were based on arrow goby collected from Newport Bay (SCCWRP 2004b). A SUF of 1 was used for the arrow goby because these fish generally exhibit site fidelity and may home to the same location after spawning (Wang 1986). Arrow gobies burrow beneath the sediment surface, and thus, arrow goby is a good candidate for establishing links between sediment and fish tissue concentrations.

3.3.2.3 Benthivorous Fish – Diamond Turbot

Diamond turbot are a common benthivorous fish in shallow sandy environments of the Pacific coast and are a prey item of piscivorous fish and wildlife. For the model, the diamond turbot weighing 100 g was assumed to feed equally on benthic polychaetes and benthic crustaceans. A fish of approximately 150 mm was used to estimate the weight, under the assumption that this would be an appropriate prey size for harbor seal. The length-weight relationship was used to estimate the weight for Diamond turbot (CDFG 2004). Adult, whole-body lipid data were not found for turbot, although a comprehensive literature search was not conducted. Instead, the average lipid content for bottom-feeding fish (5.5 percent), as reported in the WES BSAF database, was used. A conservative SUF of 1 was used for the diamond turbot because flatfish generally exhibit some site fidelity and may home to the same location after spawning (Rackowski and Pikitch 1989; Lassuy 1989).

3.3.2.4 Piscivorous Fish – California Halibut

California halibut are a long-lived and important game fish found in shallow soft bottom environments of the Pacific coast. California halibut are piscivorous and are prey for piscivorous wildlife. For the model, it was assumed that halibut fed equally on California killifish and arrow goby. The weight of a 230 mm California halibut that was taken from Newport Bay was 213 g (SCCWRP 2004b). A weight of 200g was used in the model. Adult, whole-body lipid data were not found for halibut, although a comprehensive literature search was not conducted. Instead, the average lipid content for bottom-feeding fish (5.5 percent), as reported in the WES BSAF database, was used. A SUF of 1 was used for halibut under the conservative assumption that some site fidelity may occur. (Kucas and Hassler 1986)

Table 7
Summary of Fish Model Parameters

Trophic Guild	Species	Lipid % (ww)	Weight (g)	Site Use Factor
Planktivorous fish	California killifish	1.5	5	1
Benthivorous fish	Arrow goby	1.5	2	1
Benthivorous fish	Diamond turbot	5.5	100	1
Piscivorous fish	California halibut	5.5	200	1

Table 8
Summary of Fish Dietary Components

Trophic Guild	Species	Prey Item	Percent of Diet
Planktivorous fish	California killifish	Pelagic crustacean	100%
Benthivorous fish	Arrow goby	Benthic polychaete	50%
		Benthic crustacean	50%
Benthivorous fish	Diamond turbot	Benthic polychaete	50%
		Benthic crustacean	50%
Piscivorous fish	California halibut	California Killifish	50%
		Arrow Goby	50%

3.3.3 Wildlife

Four wildlife species were evaluated in this assessment, three birds and one marine mammal. As noted above, the three bird species were selected because of their threatened or endangered status. Body weights, ingestion rates, and SUFs are provided in Table 9. Table 10 summarizes the dietary components of the modeled wildlife.

Exposure data for wildlife were obtained from the California Wildlife Habitat Relationships System (CDFG 2003b) (http://www.dfg.ca/gov/whdab), CalEcotox (2003) (http://www.oehha.org/cal_ecotox/), and the Wildlife Exposure Factors Handbook (USEPA 1993). Where appropriate, wildlife SUFs were calculated based on the area of Rhine Channel, approximately 7 ha.

3.3.3.1 Brown Pelican

The brown pelican feeds almost entirely on planktonic fish (CDFG 2003b and CalEcotox 2003). CalEcotox (2003) reported that northern anchovy made up 80 percent of the diet in nestlings. For the model, it was assumed that the killifish, a planktivore, made up 100 percent of the pelican diet. The body weight of the brown pelican (3.4 kg) was based on the midrange of adult birds reported by CalEcotox (2003). The ingestion rate of 760 g/day was calculated using the seabird allometric equation for food ingestion and adjusted to wet weight assuming 80 percent moisture content (USEPA 1993). The reported foraging distance for juvenile brown pelicans was 10 km to 50 km (CalEcotox 2003). The lower bay of Newport Beach is approximately 300 ha (Corps 2005). Under the assumption that the pelican selected only prey items from Lower Newport Bay a foraging area was estimated to be approximately 300 ha. The area of the Rhine Channel is approximately 7 ha. Therefore, conservatively rounding up the area of influence of the Rhine Channel to 10 ha, an SUF of 0.03 was used for the brown pelican. Because of its large food requirements and distant breeding grounds in the Channel Islands, this SUF is likely conservative (CDFG 2003b).

3.3.3.2 Cormorant

The double crested cormorant feeds almost entirely on fish (CDFG 2003b and CalEcotox 2003). CalEcotox (2003) reported that flat fish, sculpins, and anchovy made up 80 percent of the diet. For the model, it was assumed that the killifish and arrow goby made up equal parts of the cormorant diet. The body weight of the double crested cormorant (1.3 kg) was based on the low range of adult birds reported by CalEcotox (2003). The ingestion rate of 385 g/day was calculated using the seabird allometric equation for food ingestion and adjusted to wet weight assuming 80 percent moisture content (USEPA 1993). The reported foraging distance for double crested cormorants was 3.5 km to 61.8 km (CalEcotox 2003). To ensure a conservative evaluation of risk to piscivorous birds, a SUF of 1 was applied to cormorant.

3.3.3.3 Harbor Seal

Harbor seals feed opportunistically on fish and invertebrates. For the model, it was assumed that halibut and diamond turbot made up equal parts of the diet. The body weight of harbor seal was based on an adult average of 82 kg (ADFG 2003). The food ingestion rate, 13 kg/day wet weight (ww) was calculated based on the mammal allometric equation for food ingestion and adjusted to wet weight assuming 80 percent moisture content (EPA 1993). Alaska Department of Fish and Game (2003) reports that harbor seals make "considerable local movements" on the order of over 100 km. A SUF of 0.05, representing a 200 ha of suitable foraging area in lower Newport Bay was used for harbor seal. Because of its documented movements and large food requirements on the order of 5 to 6 percent of body weight per day (CDFG 2003b), it is likely that this SUF is conservative.

Table 9
Summary of Wildlife Model Parameters

Trophic Guild	Species	Body Weight (kg)	Ingestion Rate (kg/day ww)	Site Use Factor
Avifauna				
Piscivorous birds	Brown pelican	3.4	0.76	0.03
	Cormorant	1.3	0.385	1
Mammals				
	Harbor seal	82	13	0.05

Table 10
Summary of Wildlife Dietary Components

Trophic Guild	Species	Prey Item	Percent of Diet
Avifauna			
Piscivorous Birds	Brown pelican	Killifish	100
	Cormorant	Killifish	50
		Arrow goby	50
Mammals			
	Harbor seal	Diamond turbot	50
		California halibut	50

4 EFFECTS ASSESSMENT

This section describes the selection of TRVs for the COPC-ROC pairs. TRVs were selected to ensure a conservative determination of risk. Rather than conducting a comprehensive literature search, existing risk evaluations, including the Trophic Trace examples and major risk assessments, were the primary sources of data. Where possible, no observable apparent effects levels (NOAEL) and lowest observable apparent effects levels (LOAEL), obtained from laboratory studies, were used to provide a better evaluation of TRV uncertainty.

4.1 Fish

A tissue-based approach was used to evaluate toxicity to fish from exposure to mercury, PCBs, and DDE. Because copper and selenium are essential mineral nutrients and can be compartmentalized in specific organs, a dietary approach is generally taken for these metals and was applied for this model (Chapman et al. 2003). Fish TRVs are presented in Table 11.

The Trophic Trace default TRVs for DDE and PCBs were used in this assessment. For DDE, Hamelink et al. (1971) reported a LOAEL of 24 mg/kg for green sunfish and pumpkinseed based on survival. The DDE NOAEL was estimated using an uncertainty factor of 10. For PCBs, Hansen et al. (1973) reported a LOAEL of 9.3 mg/kg and a NOAEL of 1.9 mg/kg for sheepshead minnow based on reproductive endpoints.

For mercury, a NOAEL of 0.2 mg/kg and a LOAEL of 0.47 mg/kg, both based on survival of mummichog, were taken from Matta et al. (2001). The Matta et al. (2001) values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by USEPA Region 10 in 2003 (Windward 2003).

For copper, a dietary NOAEL of 8 mg/kg and a LOAEL of 16 mg/kg, both based on growth of channel catfish were taken from Murai et al. (1981). The Murai et al. (1981) values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by USEPA Region 10 in 2003 (Windward 2003).

For selenium, a dietary NOAEL of 3.9 mg/kg and a LOAEL of 7.3 mg/kg, both based on mortality in bluegill were taken from Cleveland et al. (1993). The Cleveland et al. (1993)

values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by Region 10 USEPA in 2003 (Windward 2003).

Table 11
Summary of Fish Toxicity Reference Values

Chemical	Dietary NOAEL (mg/kg per day)	Dietary LOAEL (mg/kg per day)	Tissue NOAEL (mg/kg)	Tissue LOAEL (mg/kg)	Source
Copper	8	16	--	--	Murai et al. 1981
Selenium	3.9	7.3	--	--	Cleveland et al. 1993
Mercury	--	--	0.2	0.47	Matta et al. 2001
DDTs	--	--	2.4	24	Hamelink et al. 1971
PCBs	--	--	1.9	9.3	Hansen et al. 1973

4.2 Wildlife

A dietary dose approach was used to evaluate toxicity to birds and mammals. An egg biomagnification approach was used to evaluate reproductive effects in birds from PCBs and DDE.

4.2.1.1 Birds

For PCBs and birds, the LOAEL value for both dietary and egg effects (0.41 mg/kg day and 7.1 mg/kg-day, respectively) were taken from a study of ringed turtle dove hatching success by Peakall et al. (1972). The dietary and egg effect NOAEL data (0.94 mg/kg and 16 mg/kg, respectively) were taken from a study with screech owl by McLane and Hughes (1980). These study values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by USEPA Region 10 in 2003 (Windward 2003).

Concentrations of COPCs in bird eggs were estimated using biomagnification factors. For PCBs and DDE, a biomagnification factor of 28 was used. This is the same value that was used in the Trophic Trace examples for these chemicals. For bird eggs and DDTs, TRVs were selected from CalEcotox. Specific LOAEL or NOAELs were not available from CalEcotox; however a LOAEL-type value of

8 mg/kg was selected that was reported as the critical threshold DDE concentration in brown pelican eggs associated with 20 percent eggshell thinning. A NOAEL-type value was not available from CalEcotox; however, 3 mg/kg was a level where nests fledged at least one chick. These values were similar to the eggshell thinning data provided in the Trophic Trace examples for Osprey and Bald Eagle and are similar to those values used in other risk assessments (RETEC 2002).

For brown pelican, the dietary DDE toxicity value selected was the LOAEL (0.028 mg/kg per day) reported for this species by Sample et al. (1996). A NOAEL (0.0028 mg/kg per day) was estimated using an uncertainty factor of 10.

For cormorant, the DDE NOAEL of 0.084 mg/kg body weight (bw) per day This value was derived based on American kestrel using a no-effect dietary concentration of 0.3 mg/kg ww (Lincer 1975), a body weight of 0.114 kg (CalEcotox 2003), and a food ingestion rate of 0.032 kg ww/day (calculated from Nagy 1987). A DDE LOAEL was calculated using an uncertainty factor of 10. The Lincer et al. (1975) values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by USEPA Region 10 in 2003 (Windward 2003).

For mercury, a NOAEL of 0.0091 mg/kg bw day was derived based on egret using a no-effect dietary concentration of 0.05 mg/kg ww (Spalding et al. 2000), a body weight of 1.02 kg (Arizona Game and Fish 2002), and a food ingestion rate of 0.185 kg ww/day (Kushlan 1978). A mercury LOAEL was calculated using an uncertainty factor of 10. These study values were applied in the Final Lower Duwamish Waterway ecological risk assessment, which was approved by USEPA Region 10 in 2003 (Windward 2003).

For selenium, a NOAEL of 0.42 mg/kg bw day and LOAEL of 0.82 mg/kg bw day was taken from Heinz et al. (1989), based on reproduction in mallards. For copper a NOAEL of 47 mg/kg bw day and LOAEL of 62 mg/kg bw day was taken from Mehring et al. (1960), based on growth and mortality in chicks. These study values were taken from compilation of TRVs prepared as part of the Lower Willamette River ecological risk assessment.

Table 12
Summary of Bird Toxicity Reference Values

Chemical	Dietary NOAEL (mg/kg per day)	Dietary LOAEL (mg/kg per day)	Egg NOAEL (mg/kg)	Egg LOAEL (mg/kg)
DDE	0.084	0.84	3	8
PCBs	0.41	0.94	7.1	16
Mercury	0.0091	0.091		
Copper	47	62		
Selenium	0.42	0.82		

4.2.1.2 Harbor Seal

Toxicity data were not readily available for the harbor seal. Therefore, the toxicity data for otter, provided in the Trophic Trace examples, were used. While the uncertainty in this approach is high, mustelids like otter and mink are among the most sensitive mammals to PCBs and pesticides, and therefore, the otter toxicity values are a reasonable surrogate for species-specific data. The NOAEL and LOAEL for PCBs were 0.004 and 0.04 mg/kg per day. The NOAEL and LOAEL for DDE were 0.8 and 4 mg/kg-day.

For copper, a NOAEL of 18 mg/kg bw day and LOAEL of 26 mg/kg bw day was taken from Aulerich et al. (1982), based on reproduction in mink. For mercury, a NOAEL of 0.16 mg/kg bw day and LOAEL of 0.25 mg/kg bw day was taken from Wobeser et al. (1976), based on growth and mortality in mink. For selenium, a NOAEL of 0.094 mg/kg bw day and LOAEL of 0.12 mg/kg bw day was taken from Halverson et al. (1966), based on growth in rat. These study values were taken from compilation of TRVs prepared as part of the Lower Willamette River ecological risk assessment.

5 RISK CHARACTERIZATION AND UNCERTAINTY EVALUATION

Risk to the ROCs from exposure to the COPCs in the Rhine Channel sediments was assessed using toxicity quotients (TQs). Trophic Trace provided a range of TQs based on the fuzzy math assessment of uncertainty using the minimum, mean, 95% UCL of the mean, and the maximum of the sediment and TOC concentrations. This range of values provides a method to assess the uncertainty in the risk estimates. For the risk characterization, the 95% UCL sediment concentration was used to provide the maximum reasonable exposure estimate. The 95% UCL is likely a conservative exposure estimate because the area-weighted COPC concentrations in the Rhine Channel sediments are lower. A summary of the modeling results are presented in Table 13.

For the fish, cormorant, and seal ROCs, LOAELs were used as the benchmark for which to assess risk. For brown pelican, a threatened or endangered species, NOAELs were used as the risk benchmark to ensure that individuals would be protected.

Uncertainties in the problem formulation and the exposure and effects measure have the potential to affect the conclusions of a risk assessment. The selection of COPCs was based on previous screening results. It is unlikely that the selection of COPCs would result in changes to the risk conclusions. The receptors evaluated for the risk assessment were selected to represent species with the greatest likelihood of having a complete pathway to sediment-associated COPCs. The TRVs for this assessment were the lowest values for the relevant organisms and endpoints that were available in the literature. It is unlikely that species not represented have greater exposure potential or are significantly more sensitive than the species evaluated. Less conservative, but appropriate and defensible, TRVs could result in predictions of marginal or no risk. Uncertainties for exposure measures are discussed below for the species evaluated.

5.1 Fish

For the metals, the BCF model approach was applied to estimating dietary- or tissue-based exposures. It is important to note that for metals, it is assumed that the bioavailable fraction of sediment associated metals is represented by the calculated, or measured, dissolved metals concentration in the water. In order to estimate the metal concentration in tissue, the water concentration is multiplied by the BCF. Relative to the modeling of non polar organics, the BCF approach is more uncertain. However, the BCF approach used conservative BCF values (USEPA 2004). For this reason, in addition to the model results, two additional, site-specific, lines of evidence were considered for evaluating risk to fish from sediment associated metals. These additional lines of evidence were the measured surface water and sediment-water interface concentrations (SCCWRP 2004a) and the measured fish tissue burdens (SCCWRP 2004b).

For copper, the modeled dietary exposure using the 2X water value (which approximates the measured dissolved water column concentration at Station NB3), exceeded the dietary NOAEL value. The modeled dietary exposure using 4X water value exceeded the LOAEL. While the 4X copper value may be greater than actual copper concentrations in the Rhine Channel, it is important to note that the measured surface water concentrations exceed the acute and chronic marine ambient water quality criteria (AWQC). Overall, it appears that there is a risk to fish in the Rhine Channel from copper. The fact that copper measured at the sediment-water interface in the Rhine Channel is ten times higher than that measured at Station NB10 indicates that the Rhine Channel sediments are a possible source.

For mercury, the BCF approach was coupled with a trophic transfer factor to estimate tissue burdens in fish for comparison to tissue-based TRVs. The modeled tissue burden using the 2X water value exceeded the dietary NOAEL value. The modeled dietary exposure using 4X water value exceeded the LOAEL. However, for mercury, the values measured by SCCWRP (2004a) were below detection limits and the detection limits were substituted into the exposure model. The mercury detection limits were well below AWQC values. Mercury tissue concentrations measured in forage fish collected from near the mouth of the Rhine Channel (SCCWRP 2004b) were also below the tissue-based TRVs. Overall, there does not appear to be a significant risk from mercury to fish in the Rhine Channel.

For selenium, none of the modeled dietary exposure levels exceeded the NOAEL. The measured water column and sediment-water interface selenium concentrations are well below the AWQC values. In addition, selenium concentrations measured in forage fish were below the dietary TRV values. Overall, there does not appear to be a significant risk from selenium to fish in the Rhine Channel.

For DDE, none of the modeled tissue burden exposure levels exceeded the NOAEL. Overall, there does not appear to be a significant risk from DDE to fish in the Rhine Channel.

For PCBs, the modeled tissue burden exposure levels based on the maximum PCB concentrations exceeded the NOAEL for killifish, turbot, and halibut. Overall, there does not appear to be a significant risk from PCBs to fish in the Rhine Channel.

5.2 Wildlife

For harbor seal, the NOAEL for PCBs was exceeded for the tissue burdens, based on the mean sediment concentration. Because all of the LOAEL TQs were less than 1, it is unlikely that the Rhine Channel sediments pose a risk to harbor seals. Although there is some uncertainty in the TRV that was used because it was based on mustelid (otter) toxicity, mustelids are among the most sensitive species to PCBs. No other chemicals had TQs greater than 1 for harbor seal. The SUF for harbor seal was 0.05, although foraging areas are likely greater than 500 ha. This source of uncertainty is acceptable to ensure that risk estimates are conservative. Overall, there does not appear to be a significant risk to seal in the Rhine Channel from any of the bioacumulative COPCs assessed herein.

For adult cormorant, the NOAEL TQs was exceeded for the 95% UCL DDE concentration; all DDE LOAEL TQs were less than 1. For cormorant eggs, the minimum DDE concentrations resulted in a NOAEL TQ greater than 1 and the 95% UCL DDE and concentration had a LOAEL TQs greater than 1. For PCBs and adult cormorant, the NOAEL TQs was only exceeded for the maximum PCB concentrations; all LOAEL TQs were less than 1. For cormorant eggs, the mean PCB concentrations resulted in a NOAEL TQ and LOAEL TQs greater than 1. Because the LOAEL TQs for the 95% UCL for PCBs and DDE were greater than 1 for cormorant eggs, risk to cormorant reproduction is possible due to bioaccumulation of these compounds from the sediment to fish tissue.

For cormorant and metals, the BCF approach was coupled with a trophic transfer factor to estimate tissue burdens in fish for comparison to the dietary-based TRVs for birds. For mercury, the modeled tissue burden using the 1X measured water value exceeded the dietary NOAEL value. The modeled dietary exposure using 4X water value exceeded the

LOAEL. However, for mercury, the surface water values measured by SCCWRP (2004a) were below detection limits and the detection limits were substituted into the exposure model. Also, the mercury detection limits were well below AWQC values. Mercury tissue concentrations measured in forage fish collected from near the mouth of the Rhine Channel (SCCWRP 2004b) were also below the dietary-based bird LOAEL (Hazard Quotient [HQ] = 0.08)[3]. Overall, there does not appear to be a significant risk to cormorant from bioaccumulation of mercury from the sediment to fish tissue. Neither copper nor selenium TRVs were exceeded for cormorant.

As noted above, brown pelican is a threatened or endangered species and therefore NOAELs were used as the risk benchmark to ensure that individuals would be protected. For adult brown pelican, the NOAEL TQs was exceeded for the maximum DDE concentrations; all DDE LOAEL TQs were less than 1. For brown pelican eggs, the mean DDE concentrations resulted in a NOAEL TQ greater than 1 and the maximum DDE and concentration had a LOAEL TQs greater than 1. Because the NOAEL TQs for the 95% UCL for DDE were greater than 1 for pelican eggs, risk to brown pelican reproduction is possible from exposure to DDE associated with the Rhine Channel sediments. There is uncertainty associated with the DDE TRV selected for assessing adult brown pelican due to the fact that the value was derived from uncontrolled field studies and that contaminants in addition to DDE may have been present in prey items.

For PCBs and adult pelican, all NOAEL TQs were less than 1. For brown pelican eggs, the mean PCB concentrations resulted in a NOAEL TQ and LOAEL TQs greater than 1. Because the NOAEL TQs for the 95% UCL for PCBs were greater than 1 for pelican eggs, risk to brown pelican reproduction is possible from exposure to the Rhine Channel sediments. None of the metals TRVs were exceeded for brown pelican. The SUF for brown pelican was 0.03, based on a conservative estimated foraging area of 300 ha. Although brown pelican rookeries are on the Channel Islands, and foraging areas are likely greater than 300 ha, this source of uncertainty is acceptable to ensure that risk estimates are conservative. Overall, it

[3] Based on the maximum forage fish mercury concentration, 0.026 mg/kg (SCCWRP 2004b), the estimated dose to cormorant is 0.008 mg/kg bw day. Based on the 95% UCL concentration of all mercury fish tissue samples, 0.060 mg/kg (SCCWRP 2004b), the estimated dose to cormorant is 0.02 mg/kg bw day. A fish tissue mercury concentration of approximately 0.31 mg/kg would be required to exceed the mercury LOAEL for birds.

appears that DDE and PCBs in the Rhine Channel sediment may contribute incremental risk to the reproduction of brown pelican due to bioaccumulation of these compounds from the sediment to fish tissue.

5.3 Risk Summary and Conclusions

This risk assessment evaluated the potential for adverse effects to fish, birds, and marine mammals from the Rhine Channel sediments under existing conditions. In the risk characterization, exposure and effects data were compared for the seven ROCs and five COPCs. The exposure of the ROCs to sediment-associated COPCs was evaluated for direct contact or ingestion of sediments and surface water as well as food chain transfer of contaminants from sediment and/or water → invertebrates → forage species → piscivorous species, as generally framed by the Trophic Trace model. Bioaccumulation modeling of the COPCs was used to evaluate whether food chain accumulation would result in tissue burdens or dietary doses greater than selected TRVs. Table 13 summarizes the results that were obtained based on reasonable and conservative exposure estimates.

For all fish species, dietary exposure to copper indicated potential adverse effects to survival, growth, or reproduction. In addition, it is important to note that copper measured in the Rhine Channel surface water samples exceeded AWQC acute and chronic values. Based on a weight of evidence approach that included comparison of the modeling results to measured surface water and tissue burdens of mercury and selenium, there does not appear to be a significant risk to fish in the Rhine Channel from these metals.

For cormorant and pelican adults, no risk was indicated from any of the COPCs. However for pelican and cormorant eggs, the TRVs were exceeded for PCBs and DDE, indicating potential risk to the reproduction of these birds. However, it is important to note that the evaluation was conservative and that there is substantial uncertainty around the bird exposure and effects estimates data that were applied. Overall, DDE and PCBs in the Rhine Channel sediment may contribute incremental risk to the reproduction of cormorant and brown pelican due to bioaccumulation of these compounds from the sediment to fish tissue.

Table 13
Summary of Toxicity Reference Values Exceedences at Modeled Concentrations for Bioaccumulative Contaminants of Concern and Receptors of Concern

Chemical	Arrow Goby	Killifish	Turbot	Halibut	Pelican	Cormorant	Seal
Copper	NOAEL at mean	NOAEL at mean	NOAEL at mean	NOAEL at mean			
	LOAEL at UCL95	LOAEL at UCL95	LOAEL at UCL95	LOAEL at UCL95			
	Surface water > AWQC	Surface water > AWQC	Surface water > AWQC	Surface water > AWQC			
Mercury	NOAEL at mean	NOAEL at mean	NOAEL at mean	NOAEL at mean		NOAEL at UCL95 of all measured tissue	
	LOAEL at UCL95	LOAEL at UCL95	LOAEL at UCL95	LOAEL at UCL95			
	Surface water < AWQC	Surface water < AWQC	Surface water < AWQC	Surface water < AWQC		UCL95 of all measured tissue < LOAEL	
	Measured tissue < TRV	Measured tissue < TRV	Measured tissue < TRV	Measured tissue < TRV			
Selenium							
DDE					NOAEL at max; Egg	NOAEL at UCL95 Egg	
					NOAEL at mean, Egg	NOAEL at min, Egg	
					LOAEL at max	LOAEL at UCL95	
PCBs		NOAEL at max	NOAEL at max	NOAEL at max	Egg NOAEL	NOAEL at Max Egg	NOAEL at mean
					LOAEL at mean	NOAEL	
						LOAEL at mean	

Note:
NOAEL – no observable adverse effect level
LOAEL – lowest observable adverse effect level
TRV – toxicity reference value
UCL95 – 95% upper confidence level of the mean sediment concentration
Mean – average sediment concentration
Max – maximum sediment concentration
AWQC – ambient water quality criteria

6 REFERENCES

Alaska Department of Fish and Game (ADF). 2003. Wildlife Notebook Series – Harbor Seal. (www.state.ak.us/adfg/notebook/marine/harseal.htm)

Anchor Environmental, L.L.C. (Anchor). 2005. Draft Feasibility Study and Alternatives Evaluation, Rhine Channel Sediment Remediation, Newport Bay, California.

Arizona Game & Fish. 2002. Great egret (Casmerodius albus). Arizona Game & Fish Department, Phoenix, AZ. (http://www.gf.state.az.us/frames/fishwild/ngame_f.htm.)

Audubon. 2004. Sea and Sage Coastal Christmas Bird Count December 28, 2003. Sea & Sage Audubon Society, an Orange County Chapter of the National Audubon Society. (http://exo.com/~kenyon/CoastalCBC.pdf)

Aulerich R.J., Ringer R.K., Bleavins M.R., Napolitano A. 1982. Effects of supplemental dietary copper on growth, reproductive performance and kit survival of standard dark mink and the acute toxicity of copper to mink. J Anim Sci 55(2):337-343.

CalEcotox (2003) California Wildlife Biology, Exposure Factor, and Toxicity Database. (http://www.oehha.org/cal_ecotox/)

CDFG. 2002. Biological Characteristics of Nearshore Fishes of California, Life History Database, Version 1.0. California Department of Fish and Game. October 25.

CDFG. 2003a. California Marine Sportfish Identification Web Page. California Department of Fish and Game. (http://www.dfg.ca.gov/mrd/msfhabs1.html)

CDFG. 2003b. California Wildlife Habitat Relationships System (CWHRS). California Department of Fish and Game. (http://www.dfg.ca.gov/whdab)

Chapman, P.M., et al. 2003. Conducting Ecological Risk Assessments of Inorganic Metals and Metalloids: Current Status. Human and Ecological Risk Assessment 9(4): 641-697.

Cleveland L, Little EE, Buckler DR, Wiedmeyer RH. 1993. Toxicity and bioaccumulation of waterborne and dietary selenium in juvenile bluegill (Lepomis macrochirus). Aquat Toxicol 27:265-280.

Coastkeeper. 2005. Orange County Coastkeeper web page regarding the Rhine Channel project (http://www.coastkeeper.org/projects.html)

Hamelink J.L., Waybrant R.C., Ball R.C. 1971. A proposal: exchange equilibria control the degree chlorinated hydrocarbons are biologically magnified in lentic environments. Trans Am Fish Soc 100(2):207-213.

Halverson A.W., Palmer I.S., Guss P.L. 1966. Toxicity of selenium to post-weanling rats. Toxicol Appl Pharmacol 9:477-484.

Hansen D.J., Schimmel S.C., Forester J. 1973. Aroclor 1254 in eggs of sheepshead minnows: effect on fertilization success and survival of embryos and fry. In: Proceedings of 27th Annual Conference, Southeastern Association of Game and Fish Commissioners, Hot Springs, AR, October 14 17, 1973. pp 420-426.

Heinz G.H., Hoffman D.J., Gold L.G. 1989. Impaired reproduction of mallards fed an organic form of selenium. J Wildl Manage 53(2):418-428.

Kozloff, E.N. 1993. Seashore life of the Northern Pacific Coast. University of Washington Press. Seattle, Washington.

Kucas, S.T. Jr. and T.H. Hassler. 1986. Species Profiles: Life History and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) – California Halibut. U.S. Fish and Wildlife Service Biological Report 82(11.44).

Kushlan J.A. 1978. Feeding ecology of wading birds. In: Sprunt A, Ogden JC, Winckler S, eds, Wading birds. National Audubon Society, New York, NY, pp 249-297.

Lane, D.E. and C.W. Hill (eds.). 1975. The Marine Resources of Anaheim Bay. California Department of Fish and Game. Fish Bulletin 165.

Lassuy, D.R. 1989. Species Profiles: Life History and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest) – English sole. U.S. Fish and Wildlife Service Biological Report 82(11.101).

Lincer J.L. 1975. DDE-induced eggshell-thinning in the American kestrel: a comparison of the field situation and laboratory results. J Appl Ecol 12(3):781-793.

Matta M.B., Linse J., Cairncross C., Francendese L., Kocan R.M. 2001. Reproductive and transgenerational effects of methylmercury or Aroclor 1268 on Fundulus heteroclitus. Environ Toxicol Chem 20(2):327-335.

McGeer, J.C. et al. 2003. Inverse Relationship between Bioconcentration Factor and Exposure Concentration for Metals: Implication for Hazard Assessment of Metals in the Aquatic Environment. Environmental Toxicology and Chemistry 22(5): 1017-1037.

McLane MAR, Hughes D.L. 1980. Reproductive success of screech owls fed Aroclor 1248. Arch Environ Contam Toxicol 9:661–665.

Mehring A.L., Brumbaugh J.H., Sutherland A.J., Titus H.W. 1960. The tolerance of growing chickens for dietary copper. Poult Sci 39:713-719.

Murai T., Andrews J.W., Smith Jr RG. 1981. Effects of dietary copper on channel catfish. Aquaculture 22:353-357.

Nagy K.A. 1987. Field metabolic rate and food requirement scaling in mammals and birds. Ecol Monogr 57: 111-128

Orange County. 2005. Newport Bay Watershed reports and studies web page. (http://www.ocwatersheds.com/watersheds/newportbay_reports_studies.asp)

Peakall D.B., Lincer J.L., Bloom S.E. 1972. Embryonic mortality and chromosomal alterations caused by Aroclor 1254 in ring doves. Environ Health Perspect 1:103-104.

Rackowski J.P. and E.K. Pikitch. 1989. Species Profiles: Life History and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) –Pacific and Speckled sanddabs. U.S. Fish and Wildlife Service Biological Report 82(11.107).

RETEC Group. 2002. Final baseline Human Health and Ecological Risk Assessment – Lower Fox River and Green Bay Wisconsin, Remedial Investigation and Feasibility Study.

Ricketts E.F., J. Calvin, and J.W. Hedgpeth, revised by DW Phillips. 1985. Between Pacific Tides, Fifth Edition. Stanford University Press, Stanford, California.

Sample B.E., Opresko D.M., Suter G.W. 1996. Toxicological benchmarks for wildlife. 1996 revision. ES/ERM-86/R3. Office of Environmental Management, US Department of Energy, Washington, DC.

SCCWRP. 1997. Relationship Between Depth, Latitude, and Sediment and the Structure of Benthic Infaunal Assemblages on the Mainland Shelf of Southern California. Southern California Coastal Water Research Project Authority (SCCWRP) web site. (http://www.sccwrp.org/pubs/annrpt/97/ar12.htm)

SCCWRP. 2003. Chemistry and Toxicity in Rhine Channel Sediments. Southern California Coastal Water Research Project Authority. Technical Report 391. May 2003.

SCCWRP. 2004a. Newport Bay Sediment Toxicity Studies. Southern California Coastal Water Research Project Authority. Technical Report 443. June 2004.

SCCWRP. 2004b. Bioaccumulation of Contaminants in Recreational and Forage Fish in Newport Bay, California in 2000-2002. Southern California Coastal Water Research Project Authority. Technical Report 446. June 2004.

Spalding M.G., Frederick P.C., McGill H.C., Bouton S.N., McDowell L.R. 2000. Methylmercury accumulation in tissues and its effects on growth and appetite in captive great egrets. J Wildl Diseas 36(3):411-422.

Smith, R.I. and J.T. Carlton, Eds. 1975. Light's Manual: Intertidal Invertebrates of the Central California Coast, Third Edition. University of California Press, Berkeley, California.

U.S. Army Corps of Engineers (Corps). 2003a. Trophic Trace Version 3.02. Waterways Experiment Station, Vicksburg, Mississippi. (www.wes.army.mil/el/trophictrace)

U.S. Army Corps of Engineers (Corps). 2003b. Dredged Material Evaluation and Disposal Procedures, A Users Manual for the Puget Sound Dredged Disposal Analysis (PSDDA) Program. February 2000 (updated with 2003 COC Table)

U.S. Army Corps of Engineers (Corps). 2005. Los Angeles District web page, Upper Newport Bay Harbor Project http://www.spl.usace.army.mil/newportbay/uppernewportbay.htm).

United States Environmental Protection Agency (USEPA). 1993. Wildlife Exposure Factors Handbook. U.S. Environmental Protection Agency. EPA/60/R-93/187.

USEPA. 1998a. Guidelines for Ecological Risk Assessment – Final. U.S. Environmental Protection Agency. EPA/630/R-95/002F.

USEPA. 1998b. Evaluation of Dredged Material Proposed for Discarge in the Waters of the U.S. – Testing Manual, Inland Testing Manual. U.S. Environmental Protection Agency. EPA-823B-98-004.

USEPA. 1999a. Partition Coefficients for Metals in Surface Water, Soil, and Waste, Draft. U.S. Environmental Protection Agency, Office of Solid Waste. June 22.

USEPA. 1999b. Data Collection for the Hazardous Waste Identification Rule: Section 11.0. Aquatic Food Web Data. U.S. Environmental Protection Agency. October.

USEPA. 2000. Proposed changes to the bioaccumulation testing evaluation framework and response to scientific peer reviewers comments on the existing framework for determining the suitability of dredged material to be placed at the Historic Area Remediation Site (HARS); Appendix E: Potential for Trophic Transfer of Metals in Benthic Invertebrate Prey to Finfish." U.S. Environmental Protection Agency, Region 2. October. http://www.epa.gov/region02/water/dredge/testing.htm

USEPA. 2004. Issue Paper on the Bioavailability and Bioaccumulation of Metals. U.S. Environmental Protection Agency. August 19.

Von Stackelberg, K. and A. Burmistrova. 2003. Trophic Trice Users Manual: A tool for Assessing Risks from Trophic Transfer of Sediment-Associated Contaimnants. June 24, 2003. (www.wes.army.mil/el/trophictrace)

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide to the Early Life Histories. Berkeley Digital Library Project. Technical Report 9 (FS/B10-4ATR 86-9). January 1986. http://elib.cs.berkeley.edu/kopec/tr9/html/home.html

Windward Environmental L.L.C. 2003. Lower Duwamish Waterway Remedial Investigation, Appendix A. Phase 1 Ecological Risk Assessment, Final. Prepared for U.S. Environmental Protection Agency, Region 10 and Washington State Department of Ecology Northwest Regional Office. July 3.